Quarterly Report

Covering October 1, 2006 to December 31, 2006

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Project Title

Fish Passage in Montana Culverts Phase II – Passage Goals

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Introduction

This progress report covers work completed between October 1, 2006 and December 31, 2006. Work on the project during this period has been primarily devoted to the removal of field equipment and the preliminary analysis of hydraulic/hydrologic data.

Project Objective

Culverts are a common and often cost effective means of providing transportation intersections with naturally occurring streams or rivers. Fish passage and fish habitat considerations are now typical components of the planning and design of waterway crossings. Many culverts in Montana span streams that support diverse fisheries. The health of these fisheries is an essential element of a recreational industry that draws hundreds of thousands of visitors to Montana annually. Transportation system planners, designers and managers recognize that fish passage through Montana's culverts is a concern. However, there is much contention concerning the impact that a culvert can have on a fishery. Recent basin-wide studies in Montana (Phase I of this project - final report in November 2004) indicate that the tools that some planners and designers promote for forecasting fish passage concerns may be overly conservative. This is reflected in the diversity of fish passage goals that are being considered by state agencies in the Northwest. Some managers contend that all culverts should pass all fish at all times, whereas others suggest that this is an unrealistic criterion, particularly during high flow events. Which species, life stages, and how many individuals must have fish passage access for how long, are questions that are often brought forward during discussions on the design and retrofitting of culverts to accommodate fish passage concerns. ***The problem is that for fish species and settings in Montana, the timing and number of fish that must pass a culvert to maintain viable species diversity in the watershed is unknown.***

Progress

The statistical model that has been developed to analyze the field data of primary interest (passage occurrences at any given PIT antenna) relies on inputs of physical parameters that may influence passage success. The parameter of probably the most interest is the water velocity in the culvert barrel. The spatially averaged exit velocity (sometimes referred to as *bulk velocity*, that is: *bulk velocity = flow rate ÷ cross sectional flow area*) was chosen as the indicator of the mean barrel velocity at each culvert. To arrive at a stream of velocity data that could be sampled to estimate the velocity at the timing of any individual fish detection at an antenna, the following process was used:

Step 1. Stage-discharge relationships were developed at stable cross sections on the main creek and both tributaries using the USGS method. An example for Cinnabar Creek is shown in Figure 1.

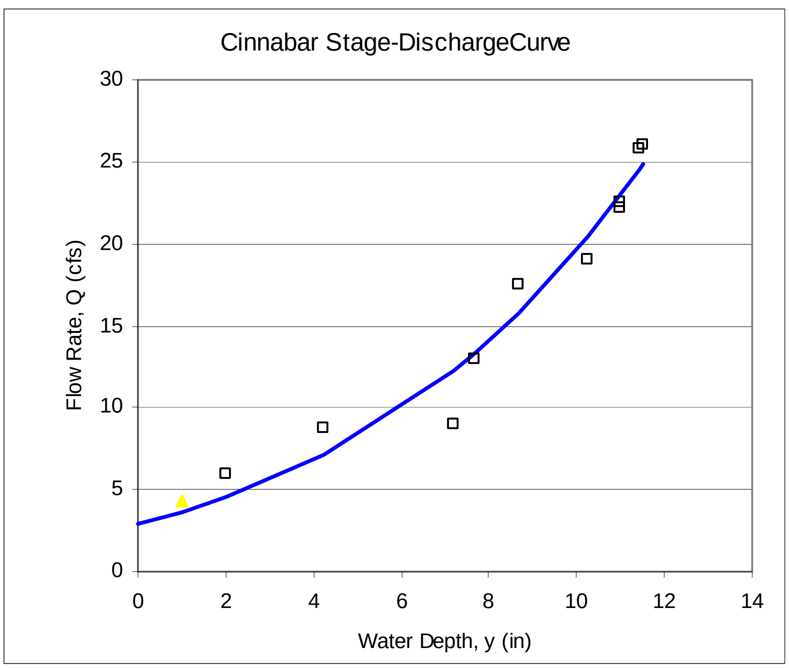

Figure 1. Stage-discharge relationship for 1996 on Cinnabar Creek.

Step 2. Stage was data-logged at the locations where the stage-discharge relationships were developed. The stage was converted to flow using the stage discharge relationships to develop continuous hydrographs for each stream. The 2006 data is shown in Figure 2.

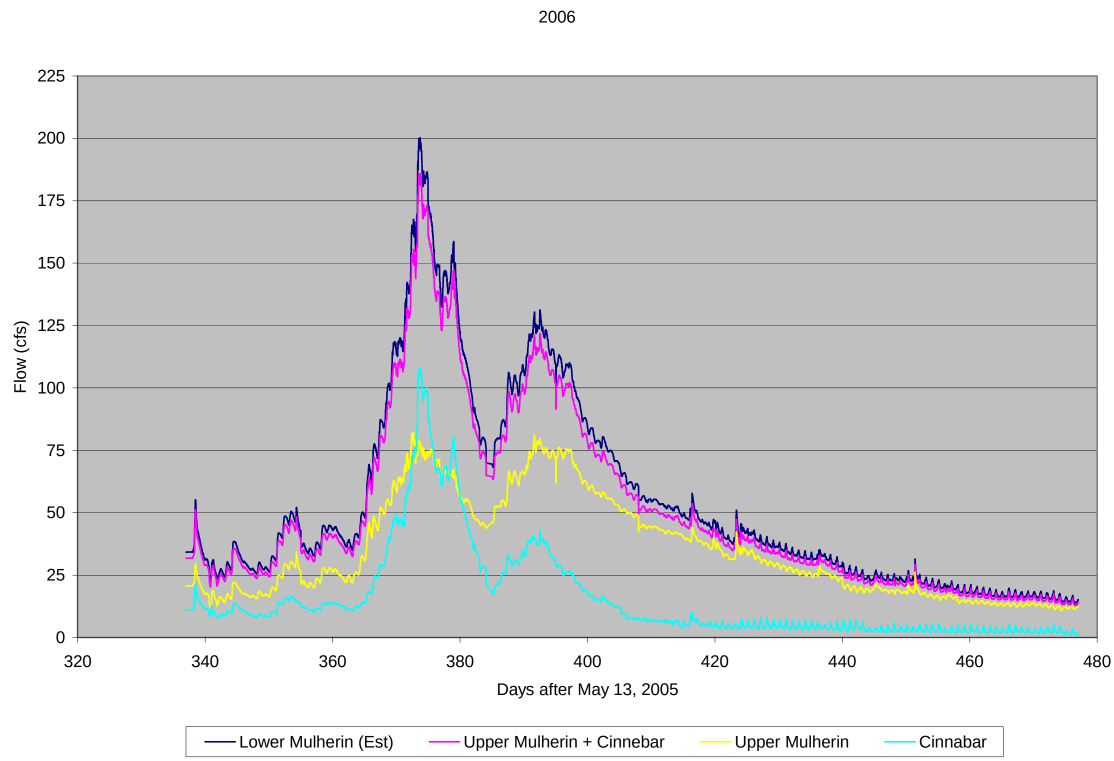

Figure 2. Hydrographs for the basin for 2006.

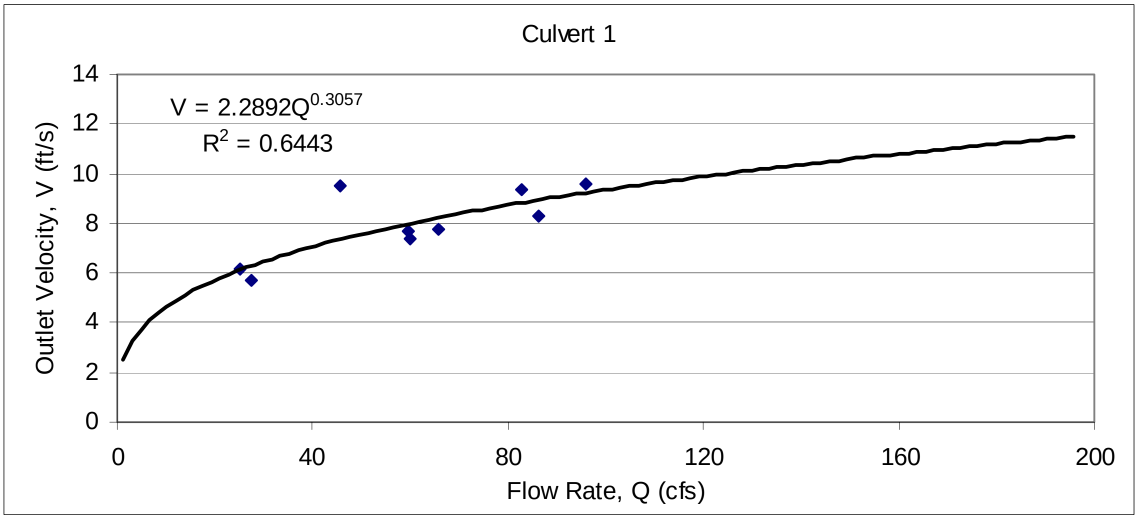

Figure 3. An example of the correlation between flow rate and bulk exit velocity for Culvert 1.

Step 3. At the same time that the flow rate was recorded at each stage-discharge site, the depth of flow at the outlet of each culvert was recorded. The depth of flow, when combined with the geometry of the culvert outlet, allowed the cross sectional flow area to be computed. Then, the computed cross sectional flow area is divided into the observed flow rate to estimate the bulk velocity at the outlet. The bulk velocity is regressed against the flow rate, so that at any point in time the data that comprises the hydrographs of Figure 2 can be used to estimate the velocity at any culvert. An example of a flow-velocity correlation is shown in Figure 3. Gradually varied flow computations were used to strengthen the relationship for Culvert 4, and to estimate the velocity-flow relationship for two control reaches downstream of the confluence of Cinnabar and Mulherin Creeks, one having the natural stream bed and one having bridge.

The hydraulic information is currently being formatted and compiled for inclusion in the statistical modeling.

Budget

Expenditures for this cycle are largely a result of stipends and travel. The planned and actual expenditures still deviate due to a change in project personnel. Stipends will be shifted to remaining personal to accomplish all the project goals as we finish out the project. Also, as before, expenditures for tuition and fees for students lag the reporting cycle.